

CLAIMS

1. A haptic feedback interface device in communication with a host computer
5 implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a device housing that is physically contacted by said user;

a sensor device operative to detect said manipulation of said interface device by said user, said sensor device outputting sensor signals representative of said manipulation; and

10 a computer-controlled electroactive polymer actuator operative to output a force to said user caused by motion of said actuator, wherein said force provides a haptic sensation to said user.

2. A haptic feedback interface device as recited in claim 1, wherein said force is
15 correlated with an event or interaction implemented by said host computer.

3. A haptic feedback interface device as recited in claim 1, wherein said force output by said electroactive polymer actuator is an inertial force that is caused by moving an inertial mass.

4. A haptic feedback interface device as recited in claim 1 further comprising a button, and wherein said electroactive polymer actuator moves said button to output said force to said
20 user.

5. A haptic feedback interface device as recited in claim 4 wherein said button is moved in a degree of freedom of motion of said button.

6. A haptic feedback interface device as recited in claim 4 wherein said button is moved laterally, approximately perpendicular to a degree of freedom of motion of said button.

7. A haptic feedback interface device as recited in claim 1 wherein said force output by said electroactive polymer actuator is a rotary force.

8. A haptic feedback interface device as recited in claim 1 wherein said force output by said electroactive polymer is a linear force.

9. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer moves portions of said device housing of said haptic feedback interface device.

10. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer moves a brake shoe against a moving part of said interface device to cause a resistance to said moving part.

11. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer provides tactile sensations when the user contacts a rotating wheel on said interface device.

12. A haptic feedback interface device as recited in claim 8 wherein said electroactive polymer actuator moves a member directly into contact or in shear with skin of said user to provide a tactile sensation to said user.

13. A haptic feedback interface device as recited in claim 12 wherein said electroactive polymer actuator is one of a plurality of electroactive polymer actuators of said interface device arrange in a tactile array.

14. A haptic feedback interface device as recited in claim 1 wherein said interface device includes a stylus.

15. A haptic feedback interface device as recited in claim 1 wherein said interface device includes a trackpoint joystick controller.

16. A haptic feedback interface device in communication with a host computer implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a sensor device operative to detect said manipulation of said interface device by said user, said sensor device outputting sensor signals representative of said manipulation; and

an electroactive polymer actuator operative to output a force to said user caused by motion of said actuator, said actuator controlled by an input electrical signal, wherein said force provides a haptic sensation to said user.

17. A haptic feedback interface device as recited in claim 16 wherein said force output by said electroactive polymer actuator is an inertial force that is caused by moving an inertial mass.

18. A haptic feedback interface device as recited in claim 16 further comprising a button,
5 and wherein said electroactive polymer actuator moves said button to output said force to said user.

19. A haptic feedback interface device as recited in claim 16 wherein said force output by said electroactive polymer actuator is a rotary force.

20. A haptic feedback interface device as recited in claim 16 wherein said force output
10 by said electroactive polymer is a linear force.

21. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer actuator bends based on at least two layers of electroactive polymer material included in said actuator.

22. A haptic feedback interface device as recited in claim 16 wherein said electroactive
15 polymer actuator includes a dielectric surrounded by two electrodes, wherein said dielectric expands in area when controlled with electrical signals.

23. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer moves portions of said device housing of said haptic feedback interface device.

24. A haptic feedback interface device as recited in claim 16 wherein said electroactive
20 polymer moves a braking member against a moving part of said interface device to cause a resistance force to said moving part.

25. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer actuator moves a member directly into contact or in shear with skin of said user to provide a tactile sensation to said user.

26. A haptic feedback interface device in communication with a host computer implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a device housing that is physically contacted by said user; and

an electroactive polymer (EAP) element, said EAP element operative to detect a manipulation of a manipulandum of said interface device and to output sensor signals representative of said manipulation, said EAP element also operative to output a force to said user in response to an input signal, said force caused by motion of said EAP element and providing a haptic sensation to said user.

27. A haptic feedback interface device as recited in claim 26 wherein said EAP element is operative to detect contact of said user with said manipulandum.

28. A haptic feedback interface device as recited in claim 26 wherein said EAP element is operative to detect an amount of pressure on said EAP element caused by said user.

29. A haptic feedback interface device as recited in claim 26 wherein said force output by said electroactive polymer is a linear force.

30. A haptic feedback interface device as recited in claim 26 wherein said interface device includes a joystick or trackpoint controller.

31. An method for outputting haptic sensations to a user of an interface device, the interface device manipulated by a user and coupled to a host microprocessor implementing a host application program, the method comprising:

detecting said manipulation of said interface device by said user and outputting sensor signals representative of said manipulation; and

outputting a force to said user using an electroactive polymer actuator by sending signals to said electroactive polymer actuator, where said force is caused by motion of said actuator, said force providing a haptic sensation to said user.

32. A method as recited in claim 31 wherein said electroactive polymer actuator outputs a rotary force.

33. A method as recited in claim 31 wherein said electroactive polymer actuator outputs a linear force.

34. A method as recited in claim 31 wherein said electroactive polymer actuator moves a braking member against a moving part of said interface device to cause a resistance force to said moving part.

35. A method as recited in claim 31 wherein said electroactive polymer moves portions
5 of a device housing of said haptic feedback interface device to provide said force to said user.

110A
110B
110C
110D
110E
110F
110G
110H
110I
110J
110K
110L
110M
110N
110O
110P
110Q
110R
110S
110T
110U
110V
110W
110X
110Y
110Z
110AA
110AB
110AC
110AD
110AE
110AF
110AG
110AH
110AI
110AJ
110AK
110AL
110AM
110AN
110AO
110AP
110AQ
110AR
110AS
110AT
110AU
110AV
110AW
110AX
110AY
110AZ
110BA
110BB
110BC
110BD
110BE
110BF
110BG
110BH
110BI
110BJ
110BK
110BL
110BM
110BN
110BO
110BP
110BQ
110BR
110BS
110BT
110BU
110BV
110BW
110BX
110BY
110BZ
110CA
110CB
110CC
110CD
110CE
110CF
110CG
110CH
110CI
110CJ
110CK
110CL
110CM
110CN
110CO
110CP
110CQ
110CR
110CS
110CT
110CU
110CV
110CW
110CX
110CY
110CZ
110DA
110DB
110DC
110DD
110DE
110DF
110DG
110DH
110DI
110DJ
110DK
110DL
110DM
110DN
110DO
110DP
110DQ
110DR
110DS
110DT
110DU
110DV
110DW
110DX
110DY
110DZ
110EA
110EB
110EC
110ED
110EE
110EF
110EG
110EH
110EI
110EJ
110EK
110EL
110EM
110EN
110EO
110EP
110EQ
110ER
110ES
110ET
110EU
110EV
110EW
110EX
110EY
110EZ
110FA
110FB
110FC
110FD
110FE
110FF
110FG
110FH
110FI
110FJ
110FK
110FL
110FM
110FN
110FO
110FP
110FQ
110FR
110FS
110FT
110FU
110FV
110FW
110FX
110FY
110FZ
110GA
110GB
110GC
110GD
110GE
110GF
110GG
110GH
110GI
110GJ
110GK
110GL
110GM
110GN
110GO
110GP
110GQ
110GR
110GS
110GT
110GU
110GV
110GW
110GX
110GY
110GZ
110HA
110HB
110HC
110HD
110HE
110HF
110HG
110HH
110HI
110HJ
110HK
110HL
110HM
110HN
110HO
110HP
110HQ
110HR
110HS
110HT
110HU
110HV
110HW
110HX
110HY
110HZ
110IA
110IB
110IC
110ID
110IE
110IF
110IG
110IH
110II
110IJ
110IK
110IL
110IM
110IN
110IO
110IP
110IQ
110IR
110IS
110IT
110IU
110IV
110IW
110IX
110IY
110IZ
110JA
110JB
110JC
110JD
110JE
110JF
110JG
110JH
110JI
110JJ
110JK
110JL
110JM
110JN
110JO
110JP
110JQ
110JR
110JS
110JT
110JU
110JV
110JW
110JX
110JY
110JZ
110KA
110KB
110KC
110KD
110KE
110KF
110KG
110KH
110KI
110KJ
110KK
110KL
110KM
110KN
110KO
110KP
110KQ
110KR
110KS
110KT
110KU
110KV
110KW
110KX
110KY
110KZ
110LA
110LB
110LC
110LD
110LE
110LF
110LG
110LH
110LI
110LJ
110LK
110LL
110LM
110LN
110LO
110LP
110LQ
110LR
110LS
110LT
110LU
110LV
110LW
110LX
110LY
110LZ
110MA
110MB
110MC
110MD
110ME
110MF
110MG
110MH
110MI
110MJ
110MK
110ML
110MM
110MN
110MO
110MP
110MQ
110MR
110MS
110MT
110MU
110MV
110MW
110MX
110MY
110MZ
110NA
110NB
110NC
110ND
110NE
110NF
110NG
110NH
110NI
110NJ
110NK
110NL
110NM
110NN
110NO
110NP
110NQ
110NR
110NS
110NT
110NU
110NV
110NW
110NX
110NY
110NZ
110OA
110OB
110OC
110OD
110OE
110OF
110OG
110OH
110OI
110OJ
110OK
110OL
110OM
110ON
110OO
110OP
110OQ
110OR
110OS
110OT
110OU
110OV
110OW
110OX
110OY
110OZ
110PA
110PB
110PC
110PD
110PE
110PF
110PG
110PH
110PI
110PJ
110PK
110PL
110PM
110PN
110PO
110PP
110PQ
110PR
110PS
110PT
110PU
110PV
110PW
110PX
110PY
110PZ
110QA
110QB
110QC
110QD
110QE
110QF
110QG
110QH
110QI
110QJ
110QK
110QL
110QM
110QN
110QO
110QP
110QQ
110QR
110QS
110QT
110QU
110QV
110QW
110QX
110QY
110QZ
110RA
110RB
110RC
110RD
110RE
110RF
110RG
110RH
110RI
110RJ
110RK
110RL
110RM
110RN
110RO
110RP
110RQ
110RR
110RS
110RT
110RU
110RV
110RW
110RX
110RY
110RZ
110SA
110SB
110SC
110SD
110SE
110SF
110SG
110SH
110SI
110SJ
110SK
110SL
110SM
110SN
110SO
110SP
110SQ
110SR
110SS
110ST
110SU
110SV
110SW
110SX
110SY
110SZ
110TA
110TB
110TC
110TD
110TE
110TF
110TG
110TH
110TI
110TJ
110TK
110TL
110TM
110TN
110TO
110TP
110TQ
110TR
110TS
110TT
110TU
110TV
110TW
110TX
110TY
110TZ
110UA
110UB
110UC
110UD
110UE
110UF
110UG
110UH
110UI
110UJ
110UK
110UL
110UM
110UN
110UO
110UP
110UQ
110UR
110US
110UT
110UU
110UV
110UW
110UX
110UY
110UZ
110VA
110VB
110VC
110VD
110VE
110VF
110VG
110VH
110VI
110VJ
110VK
110VL
110VM
110VN
110VO
110VP
110VQ
110VR
110VS
110VT
110VU
110VV
110VW
110VX
110VY
110VZ
110WA
110WB
110WC
110WD
110WE
110WF
110WG
110WH
110WI
110WJ
110WK
110WL
110WM
110WN
110WO
110WP
110WQ
110WR
110WS
110WT
110WU
110WV
110WW
110WX
110WY
110WZ
110XA
110XB
110XC
110XD
110XE
110XF
110XG
110XH
110XI
110XJ
110XK
110XL
110XM
110XN
110XO
110XP
110XQ
110XR
110XS
110XT
110XU
110XV
110XW
110XX
110XY
110XZ
110YA
110YB
110YC
110YD
110YE
110YF
110YG
110YH
110YI
110YJ
110YK
110YL
110YM
110YN
110YO
110YP
110YQ
110YR
110YS
110YT
110YU
110YV
110YW
110YX
110YY
110YZ
110ZA
110ZB
110ZC
110ZD
110ZE
110ZF
110ZG
110ZH
110ZI
110ZJ
110ZK
110ZL
110ZM
110ZN
110ZO
110ZP
110ZQ
110ZR
110ZS
110ZT
110ZU
110ZV
110ZW
110ZX
110ZY
110ZZ